Tools and Technology Note

Sweep-Net Sampling Acorns in Forested Wetlands

MITCH D. WEEGMAN,[1] *Department of Wildlife, Fisheries and Aquaculture, Box 9690, Mississippi State University, Mississippi State, MS 39762, USA*

RICHARD M. KAMINSKI, *Department of Wildlife, Fisheries and Aquaculture, Box 9690, Mississippi State University, Mississippi State, MS 39762, USA*

GUIMING WANG, *Department of Wildlife, Fisheries and Aquaculture, Box 9690, Mississippi State University, Mississippi State, MS 39762, USA*

MICHAEL L. SCHUMMER,[2] *Department of Wildlife, Fisheries and Aquaculture, Box 9690, Mississippi State University, Mississippi State, MS 39762, USA*

ANDREW W. EZELL, *Department of Forestry, Box 9681, Mississippi State University, Mississippi State, MS 39762, USA*

THEODOR D. LEININGER, *United States Department of Agriculture, Forest Service, Center for Bottomland Hardwoods Research, P.O. Box 227, Stoneville, MS 38776, USA*

ABSTRACT We are unaware of any previous studies to evaluate using a sweep net to estimate abundance of red oak acorns (*Quercus* spp.) after they fall from tree crowns, sink to the ground in flooded bottomlands (i.e., sound acorns), and become potential food for animals or propagules for seedlings. We placed known numbers of white-painted red oak acorns of 3 size classes and used a sweep net to recover them in a flooded hardwood bottomland in Noxubee National Wildlife Refuge, Mississippi, USA. We recovered large acorns 1.96 and 1.32 times more often than small and medium acorns, respectively. Mean recovery rate of all marked acorns across size and density classes was 34.0 ± 7.0% (SE, $n = 9$). Thus, sweep-net sampling for sound acorns in flooded oak bottomlands may yield negatively biased estimates of acorn abundance, and investigators should consider using correction factors.

KEY WORDS acorns, bottomland hardwoods, estimation, oak, *Quercus*, recovery rate, red oak, sweep net, waterfowl.

Red oaks (*Quercus* spp.) occur widespread in the Lower Mississippi Alluvial Valley and elsewhere in the southeastern United States (Reinecke et al. 1989, Fredrickson et al. 2005, Bonner 2008). Common species include cherrybark oak (*Q. pagoda*), Nuttall oak (*Q. texana*), pin oak (*Q. palustris*), Shumard oak (*Q. shumardii*), water oak (*Q. nigra*), and willow oak (*Q. phellos*), all of which produce acorns important for wildlife food and oak regeneration (e.g., Delnicki and Reinecke 1986, Kaminski et al. 1993, Fredrickson et al. 2005). Biologists and managers have estimated annual production of acorns (e.g., McQuilkin and Musbach 1977, Young et al. 1995, Guttery 2006), but we are unaware of any previous research to estimate abundance of acorns by any collection method after the seeds fall from trees and sink in flooded bottomlands (i.e., sound acorns; Allen and Kennedy 1989).

In flooded hardwood bottomlands, researchers have used sweep nets to collect and estimate relative abundances of acorns and aquatic invertebrates (Murkin et al. 1994, Wehrle et al. 1995), but we are unaware of any attempts to evaluate efficacy of sweep-net sampling to estimate actual acorn abundance for waterfowl and other wildlife. Therefore, we conducted an experiment to determine recovery rates of known numbers of painted sound acorns of different size classes and densities using a sweep net in a flooded hardwood bottomland.

STUDY AREA

We conducted our study in Green Tree Reservoir 1 (GTR 1; 97 ha) in Noxubee National Wildlife Refuge (NWR), Mississippi, USA. Green Tree Reservoir 1 was an impounded lowland forested area usually flooded during winter to provide waterfowl habitat and hunting opportunities (Reinecke et al. 1989). Native oaks in lowlands of Noxubee NWR included cherrybark oak, Nuttall oak, overcup oak (*Q. lyrata*), Shumard oak, water oak, and willow oak. Flat to gently sloping topography, rainfall, and overflows from the adjacent Noxubee River varied the water depth in GTR 1 during winter. Additional characteristics of the study area were described elsewhere (Kaminski et al. 1993, Wehrle et al. 1995, Ervin et al. 2006).

METHODS

The Mississippi State University (MSU) student chapter of The Wildlife Society collected approximately 1,800 acorns of each of 3 species: Shumard oak, water oak, and willow oak from the MSU campus and in adjacent Starkville, Mississippi. Students collected acorns of these species to provide representative samples of large (Shumard oak), medium (water oak), and small (willow) acorn size classes, respectively. We placed all collected acorns in water for several minutes, retained those that sunk and, hence, were sound, and sprayed air-dried sound acorns with white paint to distinguish them from naturally occurring acorns that could be recovered during sampling.

We randomly located 3 rectangular plots (2.5 m × 6.0 m) in each of 3 depth zones in GTR 1 (shallow: 15.2–21.0 cm; medium: 22.2–40.0 cm; deep: 60.3–66.7 cm) in February 2008. Each plot contained submersed leaf litter and minimal branches or other debris, but we did not attempt to quantify these items. We divided each plot into 3 rectangular subplots (0.5 m × 2.0 m), each separated by a 0.5-m × 2.0-

[1] *E-mail: mweegman@cfr.msstate.edu*
[2] *Present address: 8591 Orchard Road, Unit 3, Pinckney, MI 48169, USA*

m buffer strip, to prevent recovering acorns from adjacent subplots during sweep-net sampling. We released acorns into separate subplots in 3 densities (10 acorns/m^2, 30 acorns/m^2, and 50 acorns/m^2) to examine recovery rates of acorns immediately after release by sweep-net sampling relative to size and density of acorns. When we conducted the experiment in February 2008, we did not possess data on density of naturally occurring sound acorns; hence, we arbitrarily chose the aforementioned densities. Subsequently, J. Straub (Mississippi State University, unpublished data) estimated the following densities of sound red oak acorns in GTR 1, Noxubee NWR, for winter 2008–2009 (i.e., range = 2–49 acorns/m^2; $\bar{x}$ = 13 ± 2.6 [SE] acorns/m^2). Thus, our experimental densities of acorns were within the range of acorns found in our study area. We used a rectangular framed sweep net (21 cm × 45 cm) to recover marked acorns along the bottom of subplots using a generally applied bouncing motion (Wehrle et al. 1995).

We calculated the proportion of marked acorns recovered (*PR*) by sweeping within each 1-m^2 subplot (i.e., *PR* = no. of recovered acorns by size and density class divided by total no. of acorns placed within each subplot). We evaluated effects of acorn size and density class on recovery rate (*PR*) using a randomized complete block analysis of variance (ANOVA, α = 0.05) available in the SAS procedure MIXED (Littell et al. 2006). We used 3 sampling sites of different water depths as blocks, and we designated blocks as a random effect in ANOVA to account for unknown heterogeneity in litter, branches, and other nonmeasured variables within subplots. We designated acorn size and density as fixed effects and water depth, measured at the center of each subplot, as a covariate in the ANOVA. We used Tukey and Kramer adjustments (Littell et al. 2006) to perform multiple comparisons among least-square means of acorn recovery rates for 3 levels of acorn size and density if we detected significance within a level. We normalized recovery rate values using an arcsine transformation before performing ANOVA. We calculated 95% confidence limits by back-transforming least-square means and a nontransformed standard error for mean recovery rate over the 3 acorn size classes and 3 densities.

RESULTS

Size of acorns influenced the rate of recovery with the sweep net ($F_{2,73}$ = 12.11, $P < 0.001$). We recovered large acorns 1.96 times more often than small acorns (45% [CL = 39%, 52%] vs. 23% [17%, 28%], $t = -5.13$, df = 61, adjusted $P < 0.001$) and 1.32 times more frequently than medium acorns (34% [27%, 41%], $t = -2.64$, df = 61, adjusted P = 0.03). There was an interaction between acorn density and sampling block ($F_{4,61}$ = 2.76, P = 0.04), but acorn recovery rate varied neither with acorn density ($F_{2,73}$ = 0.83, P = 0.44) nor with variation in water depth at sample sites ($F_{1,73}$ = 3.02, P = 0.08). There were no interactions between acorn size and sample block ($F_{4,61}$ = 1.25, P = 0.30) or acorn density and size ($F_{4,61}$ = 0.8, P = 0.53). Mean recovery rate over all density and size classes was 34.0 ± 7.0% (SE, n = 9).

DISCUSSION

We recovered large acorns more frequently than medium and small acorns. Thus, bias associated with estimates of acorn abundance derived from sweep-net samples likely would increase with increasing occurrence and abundance of small acorns (e.g., willow oak). While sampling in clear water, we observed that thrust from sweep-netting may have displaced acorns from inside to outside of our sampling units, which may have contributed to the lower recovery rates for small acorns. Sweep-netting may become less effective in water deeper than we sampled because acorns of all sizes, but particularly small ones, may be displaced from sampling sites. Overall, we recovered 34% of painted acorns. Investigators collecting a range of sizes of acorns from small to large may be interested in size-specific estimates of acorn abundance and bias correction (see Results). Because of low recovery rates of acorns and other potential influencing variables (e.g., hydrology, litter, displaced acorns) in our study, we do not believe the sweep-net technique will yield accurate estimates of acorn abundance in flooded hardwood bottomlands.

Management Implications

Investigators limited to using sweep nets to estimate acorn abundance and uncertain about species, size, and density of sound acorns submersed in flooded bottomlands could use our mean recovery rate of acorns over all size and density classes (i.e., 0.34) to calculate a correction factor. We believe a superior sampling device for estimation of acorn abundance in flooded bottomlands may be one that encloses a column of water around sampling sites potentially containing submersed acorns. Such a device has been developed and evaluated; it provides estimates of acorn abundance significantly less biased than the sweep net (J. Straub, personal communication).

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